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V.N. Dvorkin H.D. Bettac Et Al

ABSTRACT

This article illucidates the technical standards and utilization ranges associated with the GPS and Glonass combined monitoring stations at Moscow and Neustrelitz. It describes in concrete terms GPS/Glonass combined receivers which Russia is in the midst of studying as well as the future utilization prospects for them in the systems in question. The next generation of receivers will be able to measure carrier wave phases making use of new speeds once each second. In conjunction with this, they will be capable of tracking 16 satellites at the same time. As far as monitoring satellite navigation systems is concerned, it is carrying out observations of connected devices with regard to slant range (illegible) related parameters, monitoring various types of error sources--for example, ephereris and almanac data, star rise time graduation and GPS and Glonass system time graduation errors as well as SGS-85 and WGS-84 coordinate system errors. It illucidates a number of differences between GPS and Glonass. It makes a preliminary comparison of the usability of Moscow and Neustrelitz satellites in order to facilitate--on the foundation of long term research--finding the mutual relationships between error sources and geography. For this reason, the conclusions obtained are capable of providing German and European users additional considerations for future development. It is figured to construct appropriate communication links between Moscow and Neustrelitz in order to facilitate exchanging navigation and positioning data. Making use of this equipment, it is also possible to produce DGPS and DGlonass difference correction values. The purpose is--within a range of 50km of a reference station--to make difference positioning accuracies reach levels of 1.5-2 meters horizontal and 2.0-2.5 meters vertical (RMS). In accordance with RTCMSC-104 standard format, difference correction values are broadcast. At the same time, independent Glonass systems and combined GPS/Glonass systems are compared in terms of different technologies they adopt and research is carried out with regard to them. Research will also be done on limitations produced due to receiver performance and added corrections as well as calibrations.

I. INTRODUCTON

Within the last few years, the global satellite navigation system (GNSS) has already become one type of powerful tool in the areas of positioning and navigation. In conjunction with this, it has achieved wide spread use. Important realms of application involve: survey network activities, traffic management, navigation applications, as well as precise orbital determinations, and so on.

The Russian Federation's Glonass system stands side by side with the U.S. Navstar-GPS system. The basic principles of these two types of GNSS are consistent.

This article, first of all, briefly discusses the two types of systems and their points of difference. The wide spread applications of these systems--which are growing every day--require a thorough understanding of the special characteristics and parameters associated with these systems. The level of understanding which people have of the Russian Glonass system is not as good as that of GPS. As a result, it is necessary to provide for users larger amounts of more precise data. Moreover, working at the compatible Glonass monitoring stations of Moscow (Russia) and Neustrelitz (Germany), it is possible to obtain these useful data. /36

II. GENERAL SYSTEM DESCRIPTION

As far as basic GNSS principles are concerned, they have already been widely carried in various types of publications (for example, [1],[2],[3]). Table 1 sets out the main parameters associated with Glonass and GPS.

Table 1 Glonass and GPS Parameters B

Parameter	Glonass	GPS
Satellite Number		
Full Satellite Constellation	21+3	21+3
Actual Satellite Constellation	13	22
Orbital Planes	3	6
Orbital Altitude	19133km	20183km
Rotation Period	11h16'	11h57'
Angle of Inclination	64.8°	55°
Eccentricity	O	O
Frequency L1	1602+CHN9/16MHz	1575.42MHz
Frequency L2	1246+CHN3/16MHz	1227.60MHz
Multiple Address Method	Frequency Seperation	Code Separation
Code Element Length		
C/A Code	58.67m	29.31m
P Code	5.867m	2.931m

Data Rate	50bps	50bps
Time Reference System	UTC (Former USSR)	UTC(U.S. Naval Observatory)
Clock	Cesium Clock	Rubidium Clock/ Cesium Clock
Coordinate System	SGS-85	WGS-84

GPS will go into full operation in 1994. Glonass, by contrast, will only be able to operate after 1995. One obvious area of difference between the two lies in Glonass--up to now--not figuring out the addition of measures to lower precisions and counter deception measures. Glonass is used as a auxilliary or complementary means for GPS. There is a requirement to even more detailed data related to space and surface portions. However, at the present time, the Russian Glonass receiver parameters which currently exist are also not completely familiar to people. The German astronavigational agency (DARA) and the Russian astronavigational agency (RKA) together--the Russian space equipment engineering research institute (RISDE) and the German aeronautic and astronautic laboratory (DLR)--are preparing to design, and, in conjunction with that, operate compatible Glonass monitoring stations located at Moscow and Neustrelitz.

The concrete missions associated with these monitoring stations are as follows:

---to collect data relating to Glonass systems as well as actual parameters.
---to make comparisons between isolated devices and connected devices as well as other monitoring stations and data acquired from other monitoring stations.
---if feasible, to compare our monitored data and the official data announced by Glonass main control station.
---to study conversion between different reference systems (coordinates, time).
---to test various types of Glonass applications.
---to combine Glonass and GPS in order to increase operating reliability. /37

IV. MONITORING STATION DESIGN

In order to complete the tasks described above, it is necessary to make use of data acquired from multiple Glonass and GPS units located at different points. At the same point, Glonass and GPS receivers should make use of the same external frequency source. The best solution method is to make use of a Glonass/GPS combination receiver--capable of carrying out C/A code, P code, and carrier wave phase measurements on L1 and L2. However, at the present time, there are only laboratory models of this type of receiver. On the market, there is only one type of advanced receiver capable of satisfying the majority of requirements

described above. A different point of view is that the necessary liaison should be carried out between the system suppliers of the Russian Glonass system and developers. On the civilian Russian market, there are only single frequency receivers. At the present time, it is only possible to supply single channel sequence receivers. The Russian space equipment engineering research institute has already designed a type of 16 channel Glonass/GPS combined receiver. However, it is also merely a C/A code receiver.

There is no way for it to carry out carrier wave phase measurements. It is said that receivers with a capability to measure carrier wave phases are expected to come out at the end of this year. It has at present already been decided to first make use of this type of 16 channel Glonass/GPS combined receiver in the first phase of monitoring stations. The equipment line and block chart in Fig.1 gives the design plan associated with the monitoring stations in question. Receivers themselves are composed of 4 radio frequency units, one common use antenna, and frequency standards. Each radio frequency unit is fitted with a signal processor board on a PC main line (16bit AT main line). Digital and analog portions of receiver operations as well as data output is controled by PC's. The PC's in question are capable of adapting to different operating methods. In conjunction with this, they are capable of making preliminary analyses with regard to data. These PC's are programed to complete the tasks set out below:

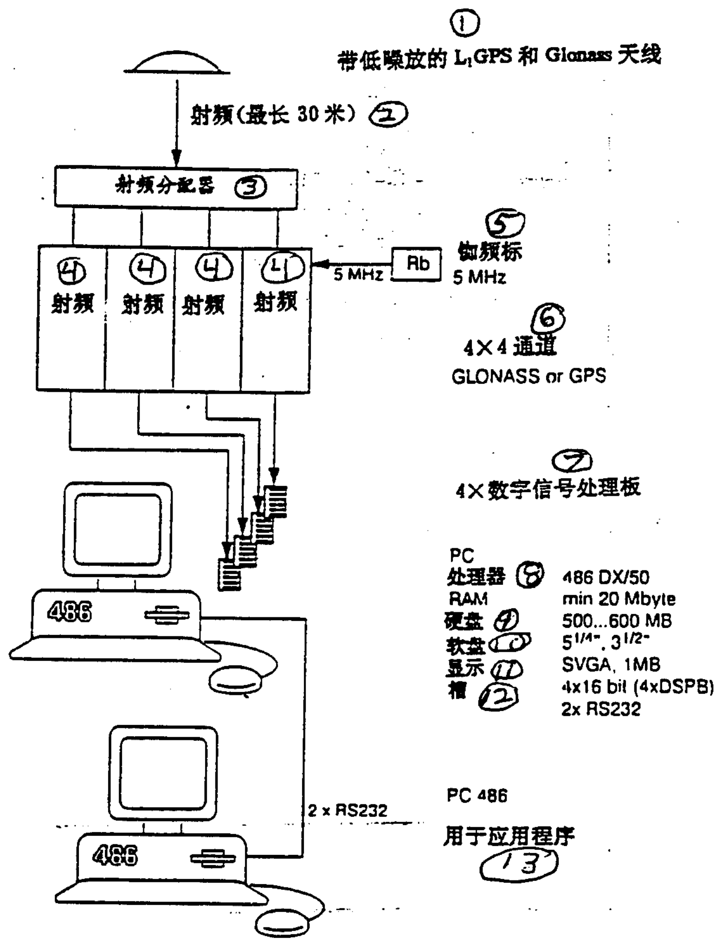

Fig.1 Monitoring Station Line and Block Chart

Key: (1) Band Low Noise Release L1 GPS and Glonass Antenna (2) Radio Frequency (Maximum Length 30 Meters) (3) Radio Frequency Distributor (4) Radio Frequency (5) Rubidium Frequency Scale (6) Channel (7) Digital Signal Processor Board (8) Processor (9) Hard Disk (10) Soft Disk (11) Display 12) (Illegible) (13) Used in Applying Programs

---to evaluate Glonass, GPS and Glonass/GPS combined receiver navigation solutions

---to store all original data received on magnetic disks

---to measure WGS84/SGS85 position differences

---to monitor GPS and Glonass system equations of time

---to use RTCM104 standard format to produce different correction values

---to take original data and derived data and send them to RS-232 connections

RS232 connections and the other PC are linked together. Here, monitoring parameters are compared to other data. The PC's in question are connected to the computer network of the station in question. Moscow and Neustrelitz computer local area networks should be connected up in order to facilitate data transfer. The first phase is the carrying out of the connection of isolated devices with the help of internal networks (FTP and TELNET) or telephone lines. After that, there will be a transition to the linking of connected devices, thereby realizing real time data transfer.

V. OUTLOOK

After the appearance of receivers capable of carrying out dual frequency carrier wave phase measurements, they will be deployed at predetermined monitoring stations. This is particularly important with regard to research on ionosphere error as well as its correction.

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